



PRECISION METER

Installation, Operation, and Parts Manual

TS10A, LPG
Electronic
Wave Form Pulser





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Our manufacturing facility is
ISO 9001:2008 and Atex Certified



Manufacturing Facility located in Fort Wayne, IN

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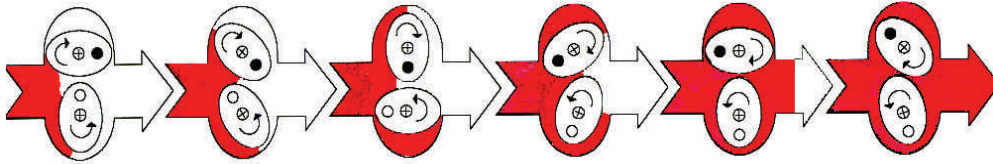
Tuthill Corporations humble beginnings date back to 1892, when James B. Tuthill purchased a clay quarry and a kiln and began supplying Chicago common bricks to local construction firms. In the early 1920's, his efforts to improve lifting clay from the quarry turned up a new transportation idea—a steam-powered truck engine.

The design eventually proved unworkable, but Tuthill recognized the value of the engine's small, internal gear pump, which injected fuel oil directly into the truck boiler. The pump design was refined and was marketed to companies that produced oil-fired boilers for use in residential and industrial heating, where it enjoyed great success and formed the basis on which the Tuthill Pump Company was formed.

Over 120 years and five generations later, Tuthill Corporation is a global presence in vacuum pumps, blowers, plastics, and fuel and chemical transfer systems. We take great pride in our "Made in USA" moniker, making quality and durability top priorities. Tuthill Precision Meters carry that legacy and competency in fluid transfer products to new levels. Our patented "Wave Form" gears provide extreme accuracy through strict control of fluid slippage in the metering chamber, and our electronics work with virtually any metering or management system.

Your choice of a Tuthill Precision Meter is an investment in professional equipment that will pay dividends for years to come. We appreciate your business, and look forward to serving you in the future!

TS Series, Principle of Operation



- Only 2 moving parts.
- Patented 'Waveform' oval gears = sustained accuracy with a minimum of maintenance.
- No metal-to-metal contact in measuring chamber or in bearings.
- The lowest differential pressure values amongst rotary PD meters.

About Tuthill Meters

We thank you for purchasing a Tuthill Meter for liquid measurement service. Tuthill Meters, formerly Fluid Power Products, is now a trade name of Tuthill Transfer Systems. Fluid Power Products was established in 1980. Since its inception, the company has been dedicated to manufacturing cost-effective, high performance flow metering devices for petroleum, industrial, commercial and municipal service.

Our facilities include computerized order entry and inventory control, so that you are assured of accurate and prompt de-liveries. Furthermore, our production personnel ensure that each order, regardless of size, receives individual attention.

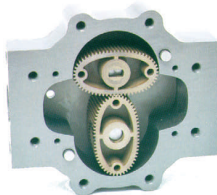
Constant attention to new product development and production design, our high standards of manufacture and final testing are the reasons why Tuthill Meters meet your most demanding requirements. With the 'Waveform' oval gear (2003 patent) meter accuracy is better than ever before.

Our meters are used in batching, blending, process control and to dispense fluids in liquid handling facilities throughout the World. Service includes gasohol blends, bio-diesel, LPG and special formulation racing fuels.

Principle of Operation

Positive Displacement meters have a measuring chamber, where inlet & outlet are separated by rotors, a rotating element or sliding vanes. As the liquid passes through the flow meter, it causes the rotors/element/vanes to turn, which forms the basis for volumetric measurement.

The Oval Gear metering principle is based on two elliptical (oval) gears, which turn on center on two horizontal shafts inside a measuring chamber formed by two overlapping cylinders. The oval gears have meshing teeth along their entire circumference, ensuring that the gears will maintain correct position in relation to each at all times, without the use of timing gears.



The volume being transferred from the inlet to the outlet side (= volume being measured) forms between the oval gear and side of the measuring chamber, alternately in the upper and lower half of the measuring chamber. In a full 360° rotate, four such known volumes are released to the downstream side of the flow meter.

With precision machining and close internal tolerances, the slippage is minimal for superior linearity (accuracy) over a broad turn-down ratio.

The TS Series meter is designed to provide:

- F●● Assy: Electrical pulse signal to an electronic register installed on the flow meter.
- W●● Assy: Electrical pulse signal to a remote electronic register.

The flow meter is 100% gland-less with static O-ring seals only. An internal magnet turns in the vertical plane; a sensor mounted in flow meter end cover reads changes in the magnetic field, and generates 64 pulses per 360° rotation. Several different signal types are available, to ensure signal compatibility with all electronic registers.

Fluid Compatibility

This Tuthill Meter assembly is specifically designed for LPG service. *Do not change service liquid, without consulting with your authorized Tuthill Meter distributor.*

Model Nominal Capacity

TS10A 40 GPM 150 lpm In LPG service:

- Normal turn-down is 5:1
- Operation at 50-65% of capacity is considered normal.
- Operation in excess of nominal capacity will cause excessive wear or premature failure.

Materials

- Case : Anodized aluminum
- Rotors : PPS with carbon bearings,
- Posts : HC303SS
- Seals : UL Buna & Viton™

Pressure Rating with 5:1 Safety Factor

350 PSI at 100°F = 24 BAR at 40°C

Temperature Rating

-40°F to +158°F = -40°C to +70°C

Safety Procedures

This manual provides warnings and procedures that are intended to inform the owner/operator of the hazards present when using the Tuthill Meters and other products. The reading of these warnings and the avoidance of such hazards is strictly in the hands of the owner/operator of the equipment. Neglect of that responsibility is not within the control of the manufacturer of the flow meter.

Read this manual as well as the literature provided in your owner's manual. If you have any questions, consult with your full-service distributor or call the Service Department at Tuthill at 260-747-7524 or 800-634-2695.

Please have the following information available when you make inquiries, order replacement parts, or schedule service. If a specific meter accessory is involved, please provide the model and serial number of the accessory in question.

Meter Serial No.: _____

Your Full Service Distributor:

Name: _____

Telephone: _____

The meters non-shock maximum operating pressure is indicated on the meter name plate. The meter should never be operated in excess of this pressure. Care should be taken to eliminate thermal and hydraulic shock pressures, so that they do not exceed the meters maximum working pressure.

IN THE EVENT OF A GAS LEAK

In the event of a large gas leak:

- Evacuate the area and notify the fire department or other appropriate authorities.

In the event of a small, contained gas leak:

- Isolate and stop the leak
- Prevent accidental ignition
- Prevent entrance of gas into other portions of the building. Be aware that LPG is heavier than air and will seek lower levels
- Evacuate all people from the danger zone
- See that the gas is dispersed before resuming the business and operations. If in doubt, notify your local authorities.

IN THE EVENT OF A GAS FIRE

In the event of large fires or fires that are spreading:

Evacuate the building and notify your local fire department. Stop the leakage only if you can safely reach the equipment.

In the event of small, contained fires that you can safely control:

Stop the leakage if you can safely reach the equipment. Then use the appropriate extinguisher: Class B fire extinguisher, water, fog, etc. depending on the equipment. If in doubt, call your local fire department.

Installation & Operation

OPERATING TEMPERATURE

TS Series W●● & F●● assemblies are rated for operation from $-40^{\circ}\text{F}/+257^{\circ}\text{F}$ ($-40^{\circ}\text{C}/+125^{\circ}\text{C}$), subject to possibly tighter ratings applicable to the electronic register.

OPERATING PRESSURE

Maximum **non-shock** Operating Pressure is:

350 PSI (24 BAR) at 100°F ($= 38^{\circ}\text{C}$)

The flow meter should never be operated in excess of this pressure. Care should be taken to eliminate thermal and hydraulic shock conditions, so that system pressure never exceeds Maximum Working Pressure rating.

SAFETY INSTRUCTIONS

Make sure that all necessary safety precautions have been taken, including proper clothing, personal safety equipment and fire safety equipment if required.

Before Start-Up of the Flow Meter, **make certain** that:

1. The meter is properly mounted, secured and piped.
2. All connections are tight.
3. All bleed and drain valves are closed.
4. Do NOT smoke near meter, or use meter near an open flame, when metering flammable liquids. Fire or Explosion could result.

Install the Flow Meter and Accessories in compliance with all applicable Local, State & Federal Construction, Electrical and Safety Codes. Additionally LPG meters must be installed in accordance with the requirements of ANSI-NFPA 58.

Installation (also see page 12):

- Positive Displacement meters are designed to operate full of liquid. The meter should be installed in a manner, so that it **remains full of liquid at all times**.
- **Hydraulic shock can be harmful to flow meter and other system components. Consideration to eliminate hydraulic shock should be given in selection of pump and design of the piping system.**
- **In critical installation, block valves and by-pass lines are recommended. This allows the meter to be serviced without interruption of flow in a critical process application.**
- **Thermal and or over pressure relief valves are recommended and should be installed whenever it is possible to block (isolate) the meter between two valves. Thermal pressures many times the operating pressure are possible with only a small rise in temperature.**
- Protective caps installed in flow meter flanges prior to shipment should remain in place until you are ready to install in the piping system.
- Keep all external surfaces of the meter clean.
- It is recommended that a **Strainer** be installed upstream of each flow meter, to prevent damage from foreign matter, such as welding slag, pipe scale or parts breaking off other equipment. When using Tuthill right-angle strainer:
 - Inlet can be either from the front or the rear of the strainer (inlet flange & strainer basket cover have same bolt pattern, and can be reversed in the field).
 - Allow adequate space for removal of strainer basket cover, so strainer basket can be cleaned.
 - Strainer basket comes standard with 200 mesh for LPG (Propane) service.
- Flush the system with a liquid compatible with the flow meter to remove all debris, scale and welding slag **prior to flow meter installation**.

If this is not possible, temporarily remove rotors (oval gears), and reinstall after the system has been flushed.
- Apply pipe compound to male threads, to **install the two companion flanges**. Tighten to a position, that allows the meter to bolt to the companion flanges, free of pipe stress.
- The **meter should always be supported** by bolting firmly to a solid platform or foundation. Never use the connecting pipe as the means of support.
- When installing the flow meter, consider future maintenance of both flow meter and accessories. The meter can be serviced in place, provided block (isolation) valves are included, and adequate space allowed.

Installation, Start-Up & Operation

- The **Vapor Eliminator** is included in the flow meter assembly, with one vent port connected to differential valve (or 3-way solenoid valve, when included). The other vent port must be piped back to storage.
- **Connections for calibration** should be provided during installation. An easy means for diverting flow into a calibration vessel (or master meter) should be considered. Refer to *Tuthill Technical Manual* for a diagram of the suggested installation.

Operation Requirements:

Upstream lines must be maintained full to prevent air/vapors from entering the meter. If the upstream or inlet lines are constructed in a manner which allows reverse flow, foot or back check valves should be installed.

Underground tanks that are furnished with a submersible pump will eliminate many problems that occur with positive displacement pumps with suction pipes, when the suction piping is incorrectly sized creating too large a lift.

Every meter should be calibrated under actual service and installation conditions. Follow your local Weights and Measures recommendations.

Give careful attention to your system's pumping equipment and piping, because of their influence on the liquid being measured as it enters the meter assembly. Systems should be designed free of conditions that cause or introduce entrained air or vapor.

positive suction head (NPSH) conditions when suction pumping is required. Following the manufactures' recommendations will minimize air and vapor elimination problems.

Start-Up:

Fill the system slowly to avoid operation on air or vapor. This can be accomplished in the following manner:

- Throttle the meter inlet valve, and allow the meter and piping to fill slowly by gravity.
- Crack open the outlet valve and start the pump, then slowly open the inlet valve until the system is up to pressure. Open the outlet valve fully to establish full flow. Check the flow rate to assure the meter is operating within specified rates.

The meter is not designed to operate on air, but the design and materials of construction of the Tuthill Meter allows for operation on vapor for short periods of time without damage to the elliptical gears or other meter internals.

Note: **Overspeeding and hammer caused by the presence of vapor in the system can cause internal damage to the meter.**

Torque Chart

Installation & Operation continued

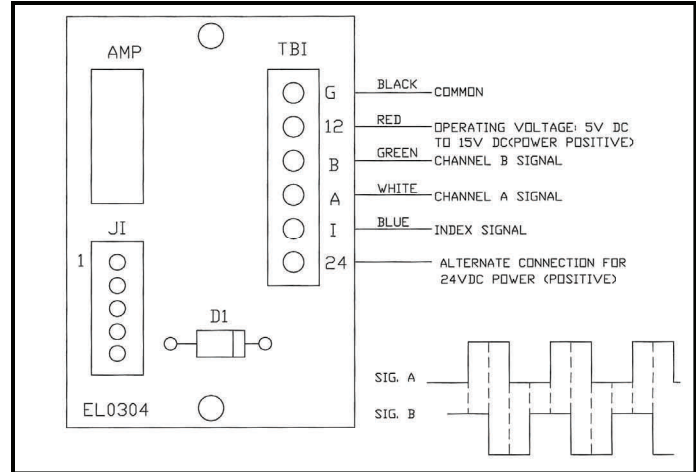
A. EL0304 Terminal Block Board (TBB)

EL0305 TBB/Amplifier

EL0305 is used for **remote** high frequency electronic registers accepting quadrature signal, when the cable distance is in 200-600' (60-180 m) range.

For greater distances external amplifier (2xPIA-300) is required.

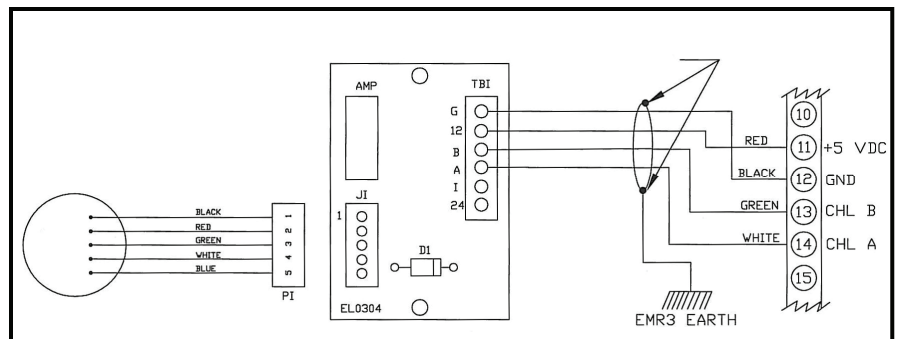
- Pulser cable plugs into:
 - **J1** on EL0304
 - **AMP** on EL0305
- Signal output cable is connected to **TB1**



B. EL0304 to EMR³ Register

EL0305 TBB/Amplifier to EMR³ Register

- Pulser cable plugs into:
 - **J1** on EL0304
 - **AMP** on EL0305
- Signal output cable is connected to **TB1**



Installation & Operation continued

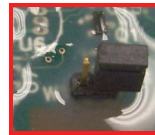
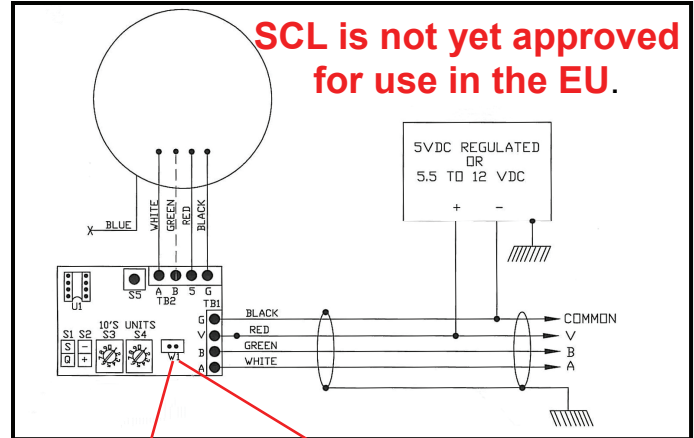
C. EL0300 Scaler/Calibrator/Linearizer (SCL)

While the SCL can have multiple functions, in many cases it is included strictly as a signal conditioner (= 'Jitter filter'). In those cases, only the calibrator function is active.

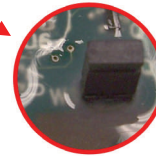
- Pulser plug is removed. Pulser leads are connected directly to **TB2** on the SCL.
- Signal output cable is connected to **TB1**.

This diagram applies to the ELNC register, when the flow meter/register are used **in non-hazardous zone**.

It also applies to LectroCount™ and other lower frequency registers with quadrature input.



W1: Both pins covered
= 5VDC regulated

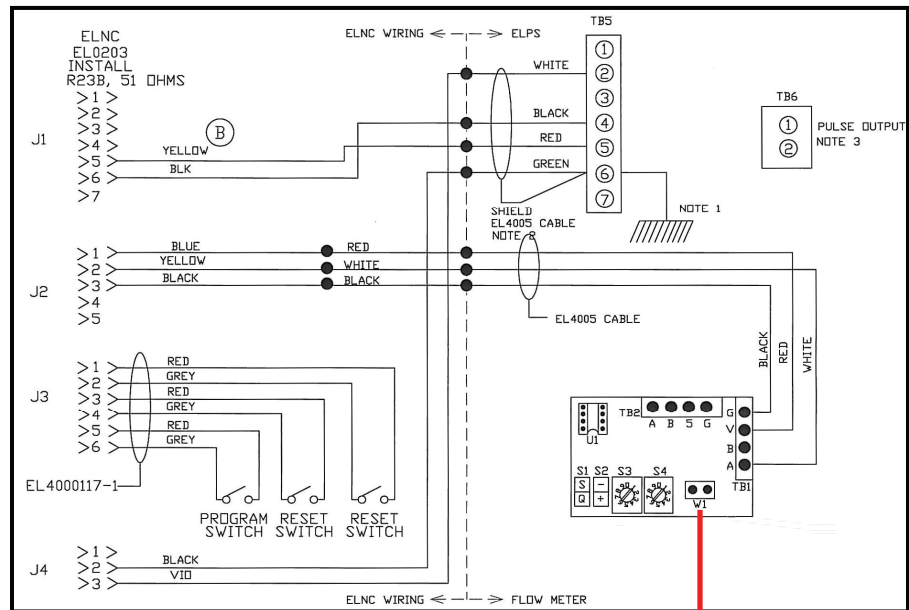


W1: 1 pin exposed
= 5.5-12VDC non-regulated

D. EL0300 (SCL), EL2057 Energy Limited Power Supply (ELPS) & ELNC Register

When flow meter/ELNC register is used in a hazardous zone, the EL2057 (AC/DC power supply & barrier, UL listed) must be used. EL2057 is in a NEMA 7 enclosure (Exp-Proof, but not water proof), so it must be installed under roof or inside a water proof cabinet.

- Pulser plug is removed. Pulser leads are connected directly to **TB2** on the SCL.
- Signal output cable is connected to **TB1**.



Note 1 : See CD1000 & CD1001 for installation of intrinsically safe apparatus.

Note 2 : Cable lengths are limited by entity parameters.

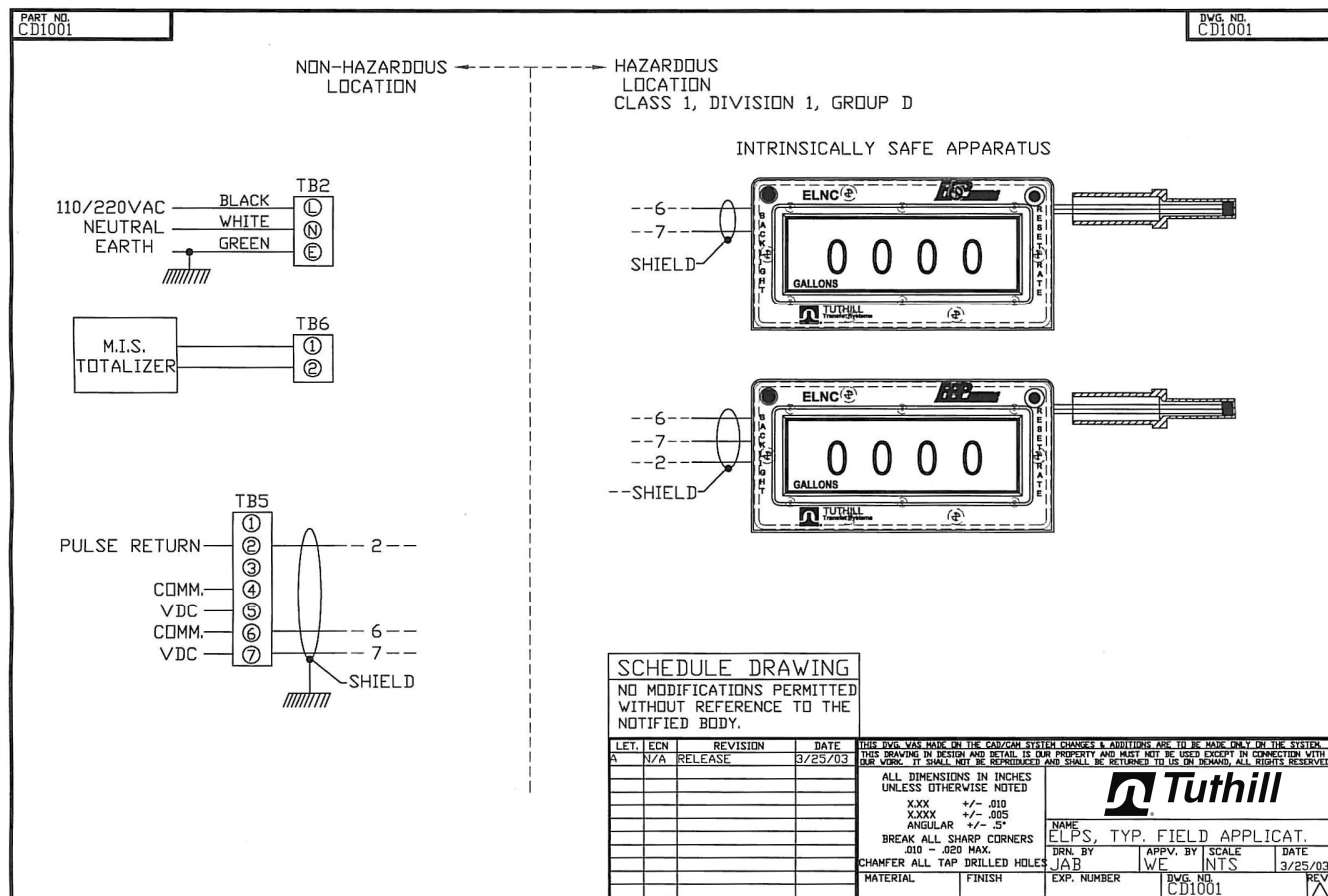
Note 3 : ELPS output option: Install U1, R3 & TB6.

EL0300-3-XXY: W1 installed = 5VDC regulated
W1 removed = 5.5-12VDC
EL0300-5-XXY: standard = 24VDC

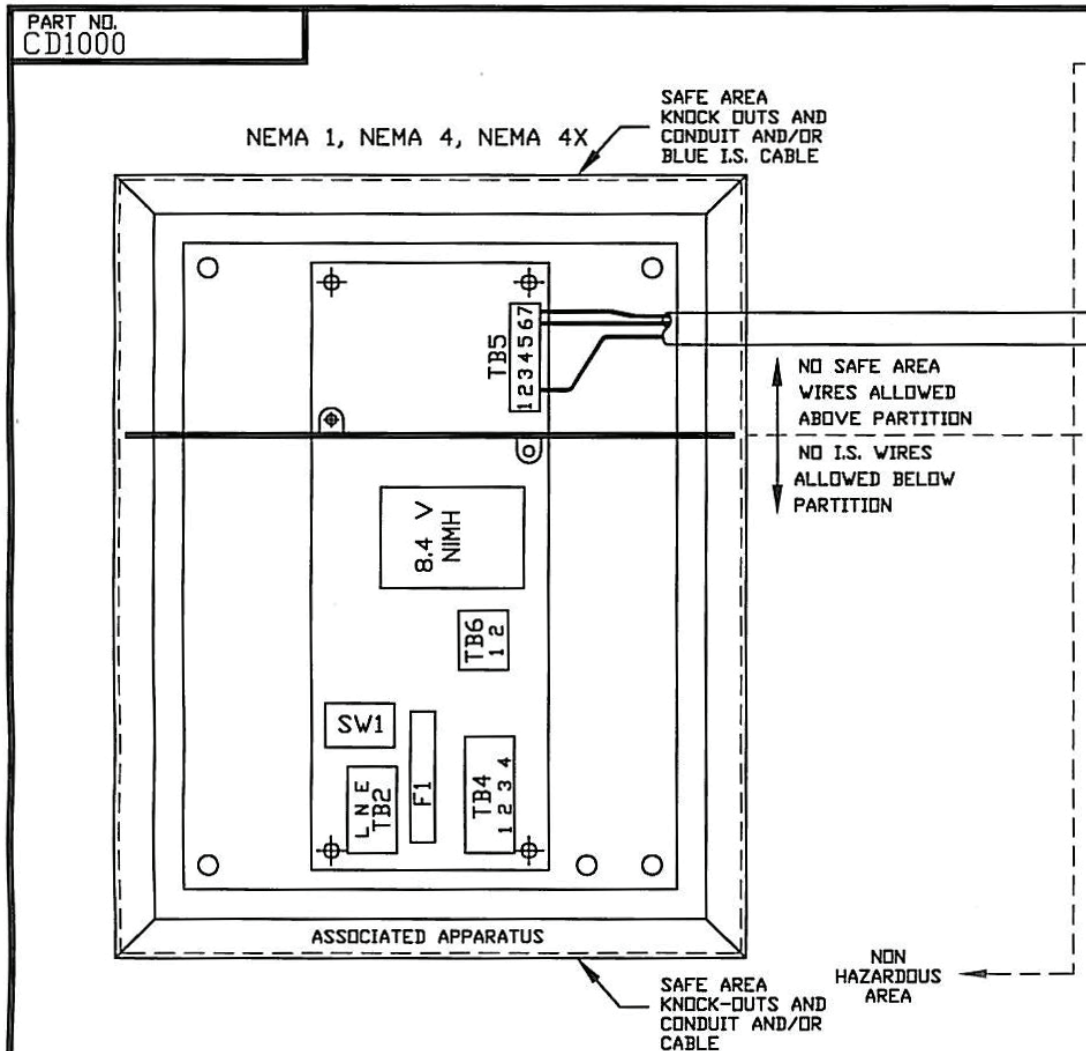
E. EL0300 to non-Quadrature Register

Same as diagram D, but connect only signal channel A.

Installation & Operation continued



Installation & Operation continued



| TERMINALS | Vt | It | Po | Ca | La |
|-----------|---------|--------|--------|------|-------|
| 2,6,7 | 10.5Vdc | 197 mA | 520 mW | 60mF | 10mH |
| 5 TO 4 | 14.201 | 1.495 | 5.3 W | 13mF | 0.1mH |

TERMINAL BLOCK TB2

- L: AC LINE (110/220). SELECT WITH SW1.
N: AC NEUTRAL
E: EARTH (TERMINAL 3 IS CONNECTED TO THE ENCLOSURE).

TERMINAL BLOCK TB5 (INTRINSICALLY SAFE CIRCUITS)

2. PULSE OUTPUT (SWITCH TO COMMON OUTPUT)
4. COMMON (DC COMMON AND EARTH)
5. 9.25 VDC 50MA UNREGULATED ENERGY LIMITED OUTPUT
6. COMMON (DC COMMON TO EARTH)
7. 9.25 VDC 50MA UNREGULATED ENERGY LIMITED OUTPUT FOR ELNC.

TERMINAL BLOCK TB6 (OPTIONAL FUNCTION)

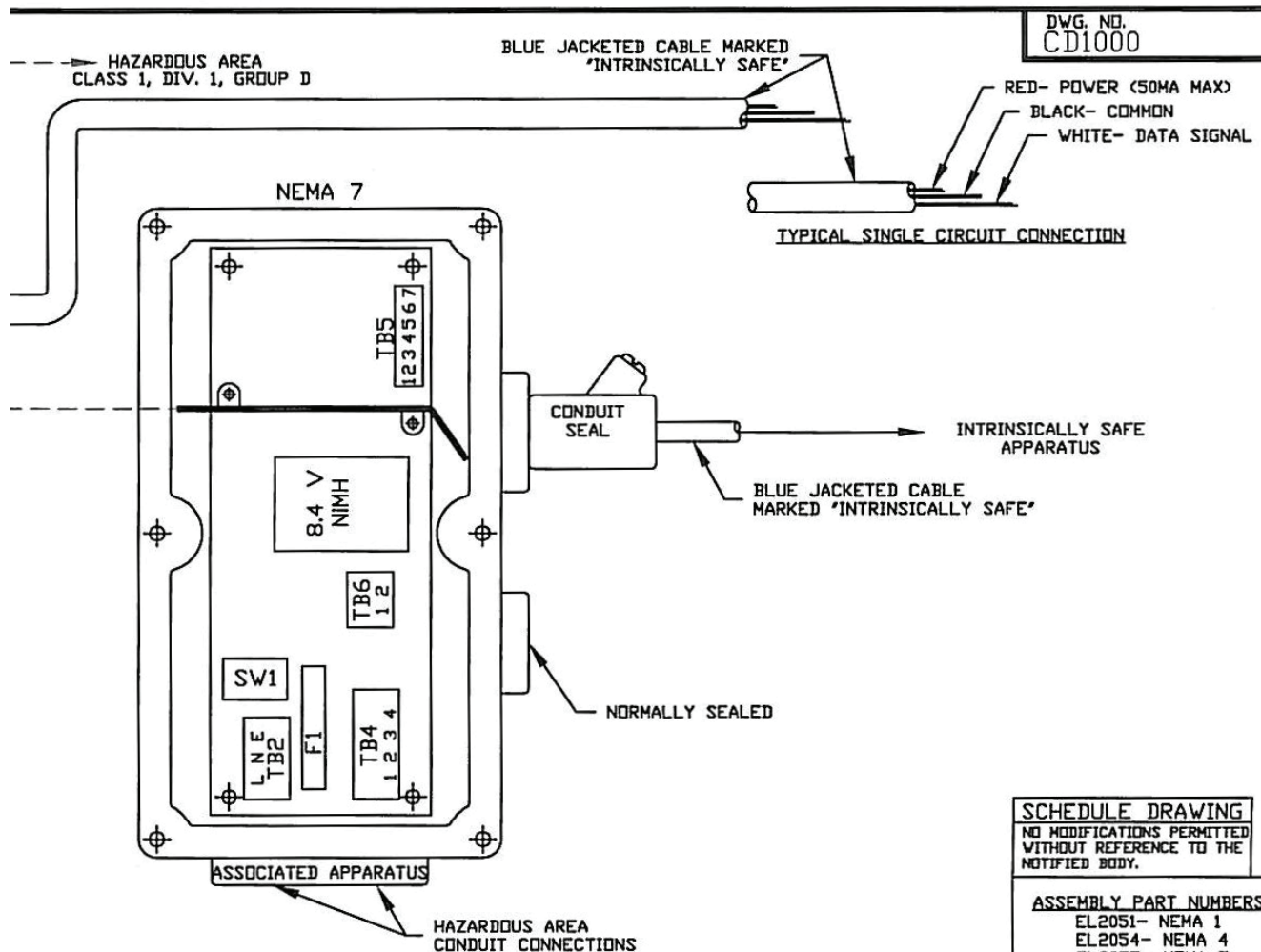
1. PULSE OUTPUT (AC/DC RELAY LOW LEVEL)
2. PULSE OUTPUT (AC/DC RELAY LOW LEVEL)

TB2-E MUST BE CONNECTED TO EARTH AND TB5-4 AND/OR TB5-6 MUST BE CONNECTED TO EARTH AT THE POWER SUPPLY ENCLOSURE.



PART OF TABLE 1

| <u>I.S. EQUIPMENT</u> | | <u>BARRIER</u> |
|-----------------------|---|----------------|
| V max | ≥ | Vt |
| I max | ≥ | It |
| P max | ≥ | Po |
| Cl + Cc | ≤ | Ca |
| Li + La | ≤ | La |

Installation & Operation continued



1. ASSOCIATED APPARATUS MAY BE IN A DIVISION 1 OR DIVISION 2 LOCATION IF SO APPROVED.
2. CAPACITANCE AND INDUCTANCE OF THE FIELD WIRING FROM THE INTRINSICALLY SAFE EQUIPMENT TO THE BARRIER SHOULD BE CALCULATED AND SHOULD BE INCLUDED IN THE SYSTEM CALCULATIONS AS SHOWN IN TABLE 1. CABLE CAPACITANCE (C_c) PLUS INTRINSICALLY SAFE EQUIPMENT CAPACITANCE (C_d) MUST BE LESS THAN THE MARKED CAPACITANCE (C_a OR C_o) SHOWN ON ANY BARRIER USED. THE SAME APPLIES FOR INDUCTANCE (L_c , L_i AND L_a OR L_o , RESPECTIVELY). WHERE THE CABLE CAPACITANCE AND INDUCTANCE PER FOOT ARE NOT KNOWN, THE FOLLOWING VALUES SHALL BE USED: $C_c=60\text{pF/ft.}$, $L_c=0.2\mu\text{H/ft.}$
3. DEVICES MUST BE INSTALLED IN ACCORDANCE WITH THIS CONTROL DRAWING, CD1001 AND ARTICLE 504 OF THE NATIONAL ELECTRICAL CODE, ANSI/NFPA 70, FOR INSTALLATION IN THE UNITED STATES, OR SECTION 18 OF THE CANADIAN ELECTRICAL CODE FOR INSTALLATIONS IN CANADA.
4. THE ASSOCIATED APPARATUS MUST BE CONNECTED TO A SUITABLE GROUND ELECTRODE PER THE NATIONAL ELECTRICAL CODE, ANSI/NFPA 70, THE CANADIAN ELECTRICAL CODE, OR OTHER LOCAL INSTALLATION CODES, AS APPLICABLE. THE RESISTANCE OF THE GROUND PATH MUST BE LESS THAN 1 OHM.
5. ASSOCIATED APPARATUS MUST NOT USE OR GENERATE MORE THAN 250 V RMS OR DC WITH RESPECT TO EARTH.

| | | | | | | | | | | | |
|------|-----|----------|---------|---|--|--------|---|----|--------------------|---------|---|
| LET. | ECN | REVISION | DATE | THIS DWG. WAS MADE ON THE CAD/CAM SYSTEM CHANGES & ADDITIONS ARE TO BE MADE ONLY ON THE SYSTEM. THIS DRAWING IN DESIGN AND DETAIL IS OUR PROPERTY AND MUST NOT BE USED EXCEPT IN CONNECTION WITH OUR WORK. IT SHALL NOT BE REPRODUCED AND SHALL BE RETURNED TO US ON DEMAND, ALL RIGHTS RESERVED. | | | | | | | |
| A | N/A | RELEASE | 3/25/03 | ALL DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED | | |  | | | | |
| | | | | X.XX +/- .010 | | | NAME CONTROL DRAWING | | | | |
| | | | | X.XXX +/- .005 | | | | | | | |
| | | | | ANGULAR +/- .5° | | | | | | | |
| | | | | BREAK ALL SHARP CORNERS .010 - .020 MAX. | | | DRN. BY | | APPV. BY | SCALE | DATE |
| | | | | CHAMFER ALL TAP DRILLED HOLES | | | JAB | WE | NTS | 3/25/03 | |
| | | | | MATERIAL | | FINISH | EXP. NUMBER | | DWG. NO. CD1000 | | REV.  |

Calibration

Theory of Operation:

The Tuthill Meter LPG metering system combines an oval gear positive displacement meter, differential valve, strainer and vapor eliminator in one assembly. The differential valve incorporates a piston type construction with the piston moving away from its seat when at least 15 PSI pressure (above product vapor pressure) is maintained at the meter outlet. The soft seat valve assures measurement accuracy by requiring pump operation for delivery, by requiring adequate back pressure to prevent product vaporization during measurement and by requiring blockage of flow when the vapor eliminator release valve is open. The strainer prevents foreign particulate from entering and damaging the meter. The meters close tolerance machine construction and no metal to metal contact provides accurate liquid measurement.

Installation on a Truck:

Flow Meter:

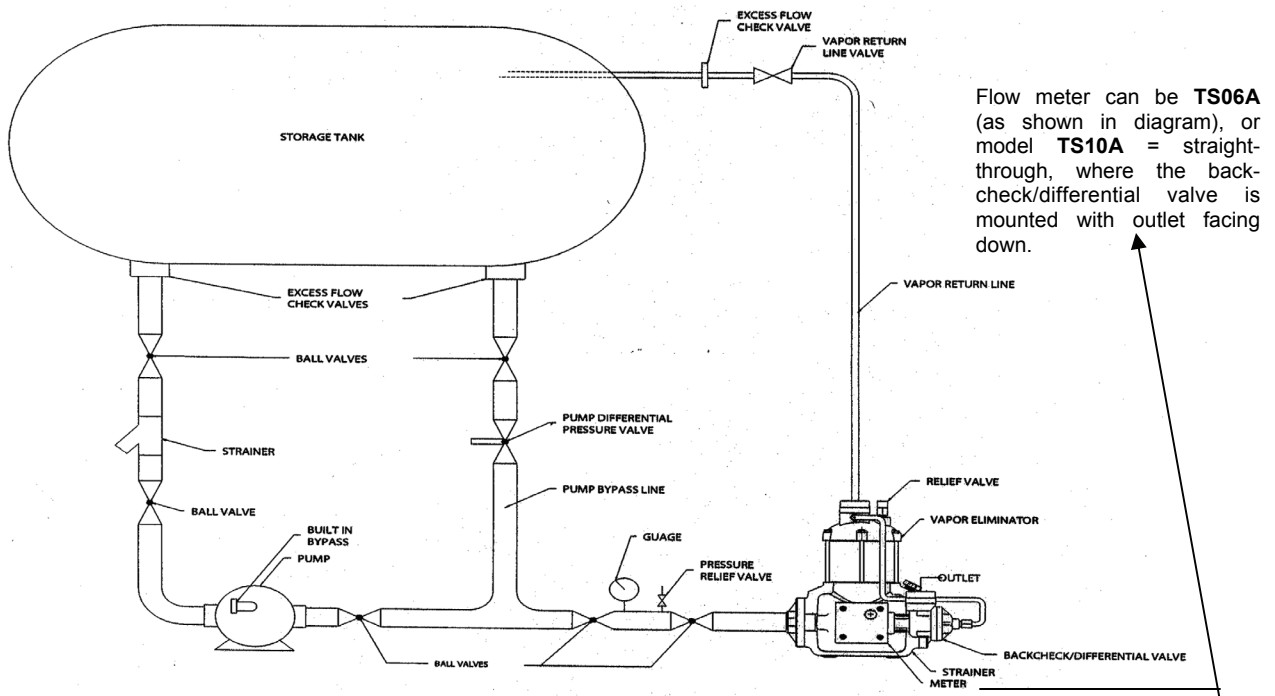
Install the meter assembly in a dispenser cabinet, or a truck deck to a secure base using the bolt holes on the "feet" of the strainer assembly base. Make inlet and outlet connections at the flanged surfaces on the strainer and differential valve, respectively. **Leave a minimum of 12 inches between the strainer flange and any obstacle for servicing the strainer.**

Vent Line:

The vent line from the meter's vapor vent to the vapor space on the supply tank should have a minimum of 1/4" inside diameter tube or pipe. A shutoff valve must be installed in the vapor vent line to allow removal of the strainer or service on the meter. The vapor release vent line must be returned to the vapor space of the supply tank and normally should not be made common with the other vapor return lines or pump bypass lines. When properly installed, this line must permit free flow in either direction. If the vent line is closed the meter will not function, as the differential valve will not open. These instructions must be followed to maintain proper function of the differential valve.

Support:

Prevent pipe strain or stress from occurring when making connections to meter or accessories and during repairs. Pipe strain and stress occurs when the pipes are not supported or are not aligned correctly to the meter. The weight of the pipes must always be supported independent of the meter. This meter and accessories can easily be removed without affecting the pipes or the pipe alignment. Never leave any of the pipes hanging.



Meter Maintenance

Danger!!

Danger!!

Danger!!

Relieve all internal pressure before servicing. Line pressure must be 0.0 PSI

Serious injury or death from fire or explosion could result from maintenance of an improperly de-pressurized and evacuated system.

Storage:

If the meter is used for seasonal work, at the end of each season the meter should be removed from the system and thoroughly flushed with a compatible liquid. This includes removing the drain on the front and rear covers. Then flush the product from the front and rear covers. If flushing with water is preferred, extra care should be taken to drain the meter completely and to dry all internal parts. Immediate refilling with a compatible liquid (or oil misting) is essential to prevent corrosion as well as ice damage to parts from moisture that was overlooked after flushing and drying.

Preparing for Service:

- Close the belly valve of the supply tank.
- Close the valve on the vapor return line.
- Close the manual valve in the supply line on the inlet side of the meter. If no manual valve exists on the inlet side, consult the bobtail manufacturer or service provider/installer for procedures to depressurize the system.
- Slowly open the valve/nozzle on the end of the supply line
- After product is bled off, close the valve/nozzle at the end of the supply line.
- Open the bleed valve provided by your installer to relieve the system pressure. Product will drain from the meter system.
- As product is bleeding from the bleed valve, slowly reopen and close the valve/nozzle on the discharge line. Repeat this step until the product stops draining from the bleed valve and discharge line valve/nozzle.
- Leave the discharge line valve/nozzle open while working on the system.

General Service:

- Do not scratch or mar any of the precision machined surfaces by prying or sanding parts.
- Torque specifications. All fasteners such as screws and bolts should be torqued to proper specifications. See the "Torque Chart" in this manual.
- Stone the machined surfaces when reassembling the meter to assure the machined surfaces are free of burrs

and scratches.

- Repair pulled threads with threaded insert fasteners. These can be used in many instances. Contact your full-service distributor for advice if this occurs.
- Coating threads: When removing and replacing bolts and screws in a meter, always coat the threads with anti-seize.
- Removing flange seals: When removing the flange assembly, always carefully remove the O-ring seal. Make sure that the flange surface is clean. Discard and replace the old O-ring seals if it is nicked or scratched in any way. If it is undamaged, it can be re-used.
- Examine all fasteners: make sure fasteners are not bent, rusted, or have pulled or burred threads. The threads should all appear evenly placed. If the bolts are bent, check the housing and cover for flatness. Use a straight edge to determine flatness. Use a stone to remove any burrs on the flat surfaces for the housing.
- Look for gaps: When disassembling a meter, use a feeler gauge to check for gaps between the post and gear plates and housing. If you do find gaps, check the plates for flatness with a straight edge. Gaps can be caused by shock problems that must be resolved. Contact your full service distributor, or the Service Department at Tuthill Meters for assistance if this occurs.
- Check the O-Rings: O-rings should be smooth. Cracked or worn O-rings should be replaced. However, a more serious problem of shock may have occurred if the O-rings are nibbled or extruded. Shock problems must be verified and resolved. Contact your full service distributor, or the Service Department at Tuthill Meters for assistance if this occurs.
- Check the post and gear plates: Check the plates for flatness. Use a straight edge. Warped plates can be caused by hydraulic shock problems that must be resolved. Contact your full service distributor, or the Service Department at Tuthill Meters for assistance if this occurs.
- Weights & Measures: Check with the regulatory agency that governs Weights and Measures in your area. Removing a seal wire may require Weight & Measures recalibration.

Meter Maintenance

Danger!!

Danger!!

Danger!!

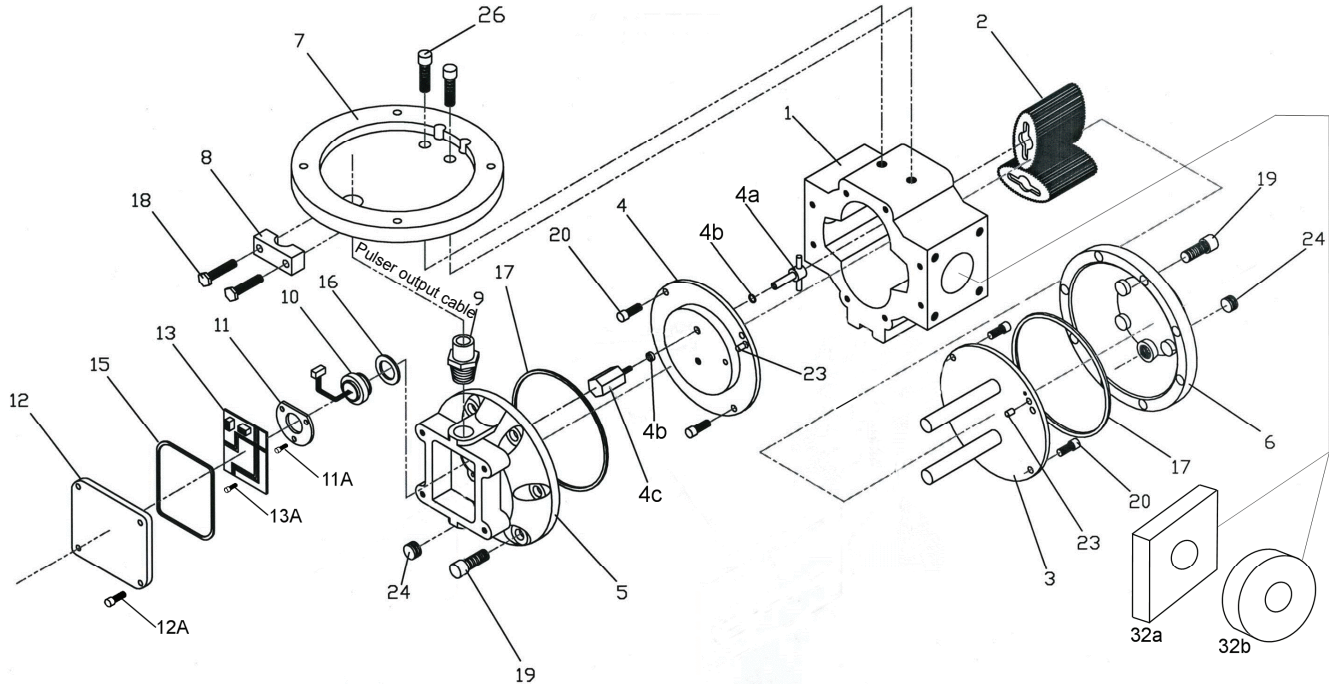
Relieve all internal pressure before servicing.

Line pressure must be 0.0 PSI

Exploded View, Flow Meter

TS10A W83: Does not include #7, #8, #18 & #26. #9 is a cord-grip.

TS10A F83 & F93: Include all components shown



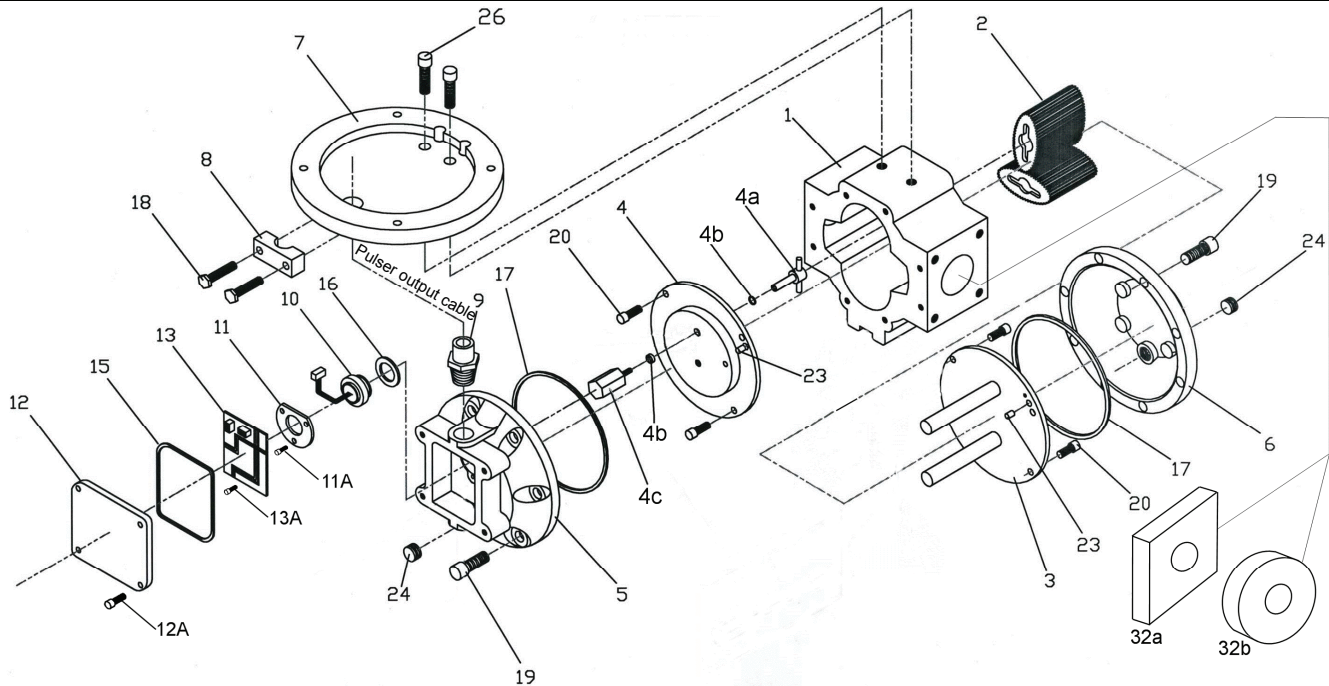
Meter Disassembly:

The great advantage of Tuthill Meters model **TS10AF83 & TS10AF93**, is that the flow meter can be **serviced in place, without removal of the electronic register, or cable connections to printer/remote controller.**

Be sure to replace all seals when servicing the meter

- Remove the security seal wire from the four pulser housing screws (#30).
- Remove the two screws (#18) from the collar (#8) on the register adaptor support. Detach the collar (#8).
- Remove the four screws (#30) from pulser housing cover. Detach the cover (#12).
- Disconnect pulser output cable from the terminal board (#13) or SCL (#13). You may replace the terminal board/ SCL at this time, if necessary. When replacing the SCL, please reference flow meter Serial No. when ordering the replacement. To replace the pulser (#10), remove three screws (#31) from the retaining plate (#11).
- Remove the eight screws (#19) from flow meter front cover (#5). Detach the front cover from meter body (#1).
- Remove the four screws (#20) from the gear plate assembly (#4). Detach the gear plate assembly.
- Inspect the gear plate (#4) for wear. Make sure that it is not scratched, or bent. If the gear plate is not damaged, it may be reused.
- Inspect the target magnet assembly (#29A) for damage or bearing wear. Significant movement between the target magnet shaft (#29C) and the bearings (#29B) indicate the need to replace the bearings.
- Replace the bearings (#29B) if necessary. It is recommended that the target magnet, bearings & drive shaft assembly be replaced at the same time.
- Remove and inspect the oval gears (#2). If the gears are not damaged or worn, they may be re-installed. They must be installed at 90° to each other to function properly.

Meter Maintenance



- Inspect the post plate and posts. Replace if there is any wear or scratches on the post plate. A small amount of polishing (surface marking) on the post plate (#3) is normal. If the polishing results in an indentation or grooves in the surface, replace the post plate assembly.

- Inspect the meter body for damage. Use 200 grit paper to remove small scratches and blemishes, if the damage is more than superficial, replace the body.

Clean all surfaces using a brush or fine (200 grit) emery cloth to remove small scratches or deposits. IF THERE ARE LARGE SCRATCHES OR DAMAGE THAT CAN CREATE A LEAK PATH, REPLACE THE PART.

- Rotate the oval gears (#2) on the posts and insure that there are no rubs between the gears and the body (#1). A Rub would indicate a bent post or a bent post plate assembly (#3). If this occurs, replace the post plate assembly (#3).
- The expectations would be, that the post plate assembly (#3) should be replaced with each second or third set of gears depending on service conditions (flow rate & total volume).
- Install a new oval gear set (#2) if necessary. Gears should be perpendicular to each other. The gears will not rotate a complete revolution if not installed properly. Once installed, the gears should rotate freely, without binds or rubs.

Check clearances between the gears and the body (#1). There should be a minimum of .003 inch (0.076 mm) between gears (#2) and the gear plate (#4). If there is any binds or rubs between the gears and the meter body,

it is recommended that the flow meter be replaced.

- Reinstall the meter gear plate (#4).
- Reinstall the cover (#5).
- It is recommended that all O-rings and seals be replaced during service. If seals are reused, a good inspection is critical.
- Reinstall the pulser (#10) and terminal board/SCL (#13) if necessary. Reconnect pulser output cable.
- Reinstall the pulser housing cover plate (#12) on front cover (#5). Replace the pulser cover "O" ring if necessary. A small amount of petroleum jelly may be used to help hold the "O" ring (#15) in place while re-installing.
- Fill the flow meter with gas, and inspect for leaks

TS10A (cast body) Parts List

| ITEM | F83 | F86 | DESCRIPTION | QTY | Part No. | |
|------|------|-----|--|-----|------------|-----|
| | F93 | W83 | | | | |
| | F96 | W86 | | | | |
| 1 | ✓ | ✓ | Meter body | 1 | MB2566 | |
| 2 | ✓ | ✓ | Gear set, PPS/carbon, LV | 1 | GSTS10RC | ** |
| 3 | ✓ | ✓ | Post Plate assembly | 1 | CP25801 | ** |
| 4 | ✓ | ✓ | Bearing Plate/WV magnet assembly | 1 | RK | ** |
| 5 | ✓ | ✓ | Front cover assembly | 1 | CP2559 | |
| 6 | ✓ | ✓ | Rear cover assembly | 1 | CP2551 | |
| 7 | ✓ | ✓ | Register mounting pad | 1 | MP1405 | |
| 8 | ✓ | ✓ | Collar, register support adaptor | 1 | MP1811 | |
| 9 | ✓ | ✓ | Support, register adaptor | 1 | MS4033 | |
| | | | Cord grip, 1/2" NPT | 1 | EL1807 | (1) |
| | | | Cable gland, 1/2" NPT | 1 | EL1845 | (2) |
| 10 | ✓ | ✓ | Sensor (pulser) | 1 | EL5519 | *** |
| 11 | ✓ | ✓ | Retaining plate, pulser | 1 | ST9250 | |
| 12 | ✓ | ✓ | Dust cover, pulser compartment, EEx d | 1 | MP1310 | |
| 13 | Std. | ✓ | Terminal Block Board | 1 | EL0304 | *** |
| | Opt. | ✓ | SCL scaler board | or | EL0300-6 | |
| 15 | ✓ | ✓ | O-ring, dust cover (EEx d only) | 1 | SL3043 | * |
| 16 | ✓ | ✓ | O-ring, pulser, UL Buna N | 1 | SL3212-UL | * |
| 17 | ✓ | ✓ | O-ring, front/rear cover, UL Buna N | 2 | SL3157-UL | * |
| 18 | ✓ | ✓ | Screw, 1/4-28 x 1" HHCS DR HD | 2 | FS0856 | |
| 19 | ✓ | ✓ | Screw, 5/16-18 x 1" SHCS | 16 | FS9901 | |
| 20 | ✓ | ✓ | Screw, #10-32 x 3/8" SHCS | 8 | FS9654 | |
| 23 | ✓ | ✓ | Dowel pin | 4 | MS902118-8 | |
| 24 | ✓ | ✓ | Drain plug, front/rear cover | 2 | MS4019 | |
| 26 | ✓ | ✓ | Bolt, 1/4-28 x 1.1/4" | 2 | FS2851 | |
| 30 | ✓ | ✓ | Screw, dust cover, with seal wire hole | 4 | FS1002 | |
| 31 | ✓ | ✓ | Screw, retaining plate | 3 | FS9520 | |
| 32a | ✓ | ✓ | Inlet/strainer adaptor | 1 | MP2407 | |
| | | | See strainer on page 12 | | | |
| 32b | ✓ | ✓ | Outlet/valve adaptor | 1 | MP2408 | |
| | | | See differential valve on page 13 | | | |

(1) This component is adequate, when register and/or pulser is powered through a suitable barrier.

(2) Required to satisfy ATEX EEx d. Must be ordered separately when required.

* Indicates recommended Spare Parts (regular maintenance items).

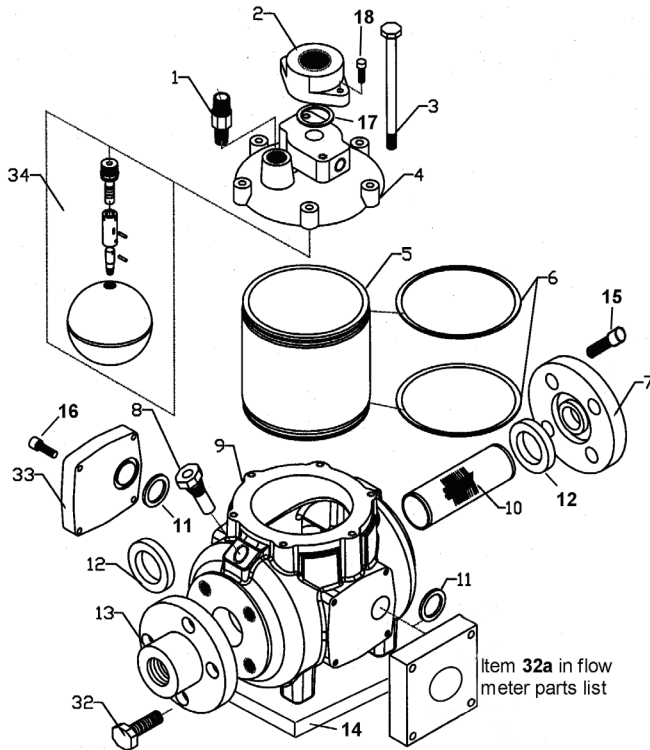
** Suggested Spare Parts (required over a longer time frame.
Should be on hand if the flow meter is in a location where service is not readily available.

*** This component will not wear out, but might be damaged by incorrect wiring or a voltage spike.

Flange kit (set of 2):

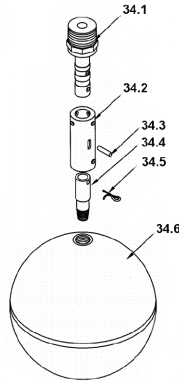
| | | | |
|------------------------------|------------|----------|----------|
| FK2156UA | 1 1/2" NPT | FK2156UB | 1/2" BSP |
| O-ring, companion flanges | | SL1122 | |
| Screws for companion flanges | | FS2950 | |

Strainer & Vapor Eliminator



Vapor Eliminator

- Disconnect the vapor return line flange (#2) and the differential valve tubing (not shown).
- Remove five bolts (#3) from the vapor eliminator housing.
- Remove the cover (#4) from the vapor eliminator housing.
- Remove the float and slide valve assembly (#34) from the cover for inspection.
- Inspect the float for damage or leakage. A crack will allow the float to fill with liquid and sink, thus preventing the valve from closing. A collapsed float is an indication of overpressure or hammer (shock) conditions. These operational conditions must be corrected before reusing the flow meter.
- Inspect the slide valve (34.1 & 34.2). Remove any build-up of salts or dirt, which may cause the valve to stick. The valve should slide freely, without any signs of sticking. There should be no scratches or burrs on the valve assembly. Replace if there are signs of damage.
- Inspect all seals, and replace if damaged or brittle.
- Re-assemble the vapor eliminator in reverse order, making sure that all bolts are torqued to the proper specifications.



Strainer

The same strainer is used with both TS06A (single or dual) & TS10A models; in single configuration, one side of the strainer is closed with a blind cover (#33). In dual configuration, a check valve is installed between the strainer and each flow meter.

When temperature compensation is required, a thermo well is available for installation in strainer body (#8). When temperature compensation is not required, the strainer is supplied with a plug instead.

- Remove the four bolts (#15) from the strainer basket cover and remove the cover (#7).
- Inspect the seal (#12) and replace if damaged or brittle
- Remove the strainer basket (#10). Clean the basket with low pressure air, blowing out all loose sediment. Wash the basket with solvent.
- Inspect the basket for holes or other damage and replace if necessary.
- Re-assemble in reverse order, making sure that all bolts are torqued to the proper specifications.

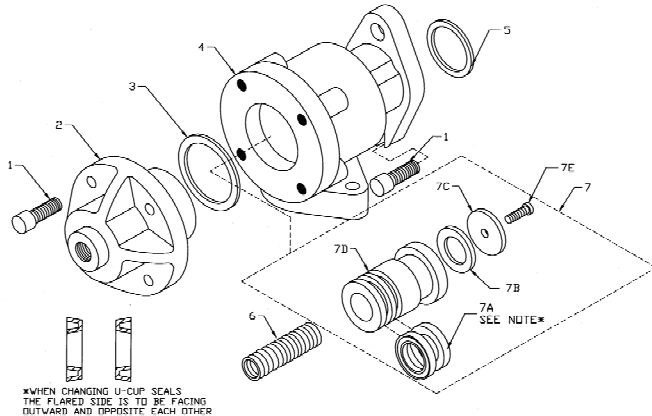
Strainer/Vapor Eliminator parts list

AE2101

AE2100

| ITEM | QTY | Part No. | Part No. |
|------|-----|----------------|----------|
| 1 | 1 | MS8400 | |
| 2 | 1 | MP1520 | |
| 3 | 6 | FS2910 | |
| 3a | 6 | FS9302 | |
| 4 | 1 | MP2561 | |
| 5 | 1 | MP2565 | |
| 6 | 2 | SL3156 | |
| 7 | 1 | MP2562 | |
| 8 | 1 | MS4021 | MP2564 |
| 9 | 1 | MP2560 | |
| 10 | 1 | SA8010-200 | |
| 10a | 1 | MS7017 | |
| 10b | 1 | MP5008 | |
| 11 | 1 | SL3123 | |
| 12 | 1 | SL3324-SQ | |
| 13 | 1 | MP2519 | |
| 32 | 4 | see flange kit | |
| 14 | 1 | MP2525 | |
| 14a | 4 | FS9302 | |
| 14b | 4 | FS2797 | |
| 15 | 4 | FS2959 | |
| 16 | 4 | FS1802 | |
| 17 | 1 | SL3127 | |
| 18a | 2 | FS9302 | |
| 18b | 2 | FS2801 | |
| 33 | 1 | MP2573 | |
| 34 | 1 | AE8201 | |
| - | 1 | MS4021 | |
| - | 1 | MS5076 | |
| - | 1 | MS5078 | |
| - | 1 | MS5074 | |

Differential Valve



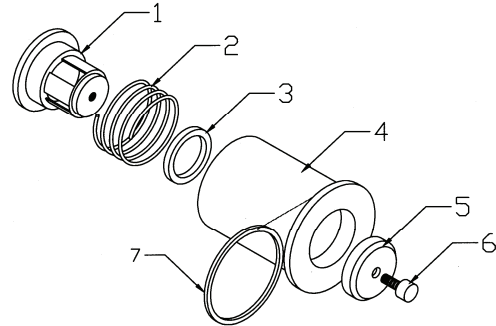
Differential Valve

- Remove the companion flange from valve outlet.
- Detach the tube from the vapor eliminator from the differential valve cover (#2).
- Remove the Screws (#1) securing the cover (2) from the valve body (#4).
- Remove the differential valve piston assembly (#7) and spring (#6).
- Inspect the valve body (#4) and cover (#2) for damage. Clean all surfaces of dirt or deposits using a fine (200 grit) emery cloth if necessary. If damage is more than superficial, replace the valve.
- Inspect all seals and replace any brittle or damaged seals. It is recommended that all seals be replaced during service.
- Replace the U-Cup seals (#7a). Note proper position of the seals. Use a small amount of Teflon lubricant to help install the seals.
- Replace the square cut seal (#7b). Use thread sealer (Locktite Blue) when installing the fastener (#7e).
- Re-assemble the valve in reverse order, making sure that bolts are torqued to the proper specifications..

DV6100 Differential Valve Parts List

| | | QTY | Part No. |
|----|---|-----|-----------|
| 1a | Bolt, 1/4"-20 x 1", ALSTPL SHCS | 6 | FS2801 |
| 1b | Lock washer, 1/4" SS | 6 | FS9302 |
| 2 | Cover, 3/4" differential valve | 1 | CP6101 |
| 3 | O-ring, UL BUNA | 1 | SL3224 |
| 4 | Valve body, 3/4" differential valve | 1 | MP6100 |
| 5 | O-ring, UL BUNA | 1 | SL3123 |
| 6 | Spring, 3/4" differential valve | 1 | MS8035 |
| 7 | Repair kit, Piston, 3/4" differential vlv | 1 | RK4000 |
| 7a | U-Cup seal, UL VITON | 2 | SL1212-U |
| 7b | O-ring, square cut, UL BUNA | 1 | SL3212-SQ |
| 7c | Seal retainer | 1 | ST6102 |
| 7d | Piston, Brass, 3/4" differential valve | 1 | MP4000 |
| 7e | Screw, 10-32 x 3/8", SHCS 303SS | 1 | FS9651 |

Opt. Inlet Check Valve (TS06AS84 only)



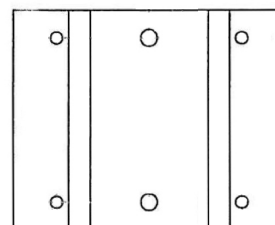
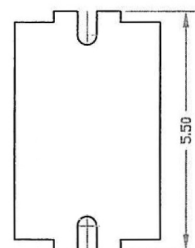
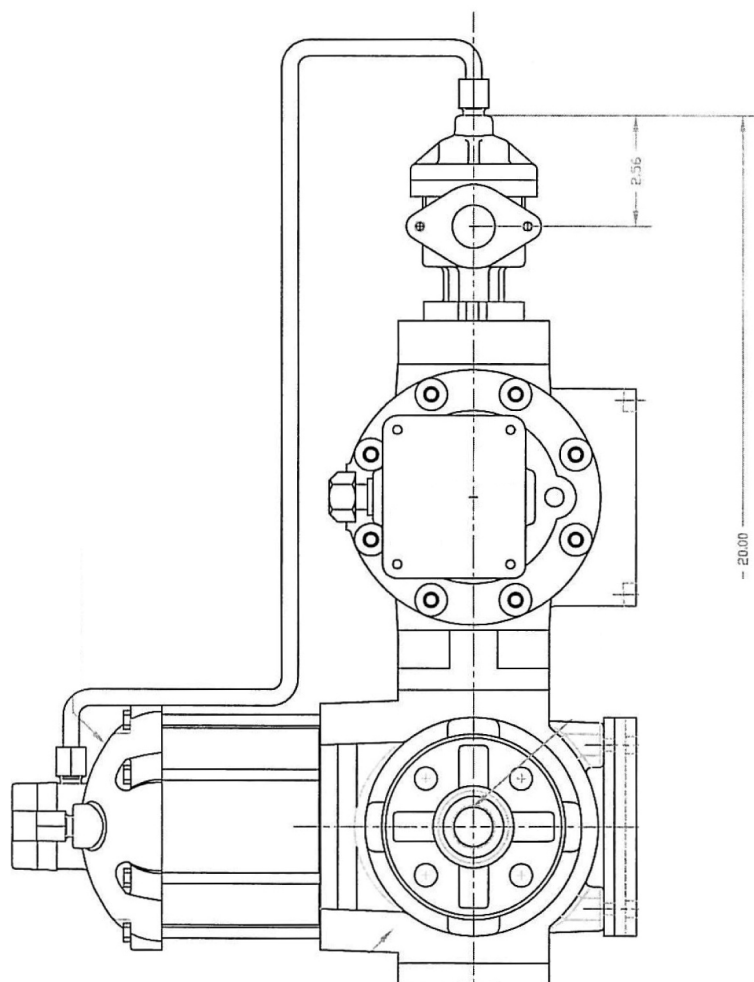
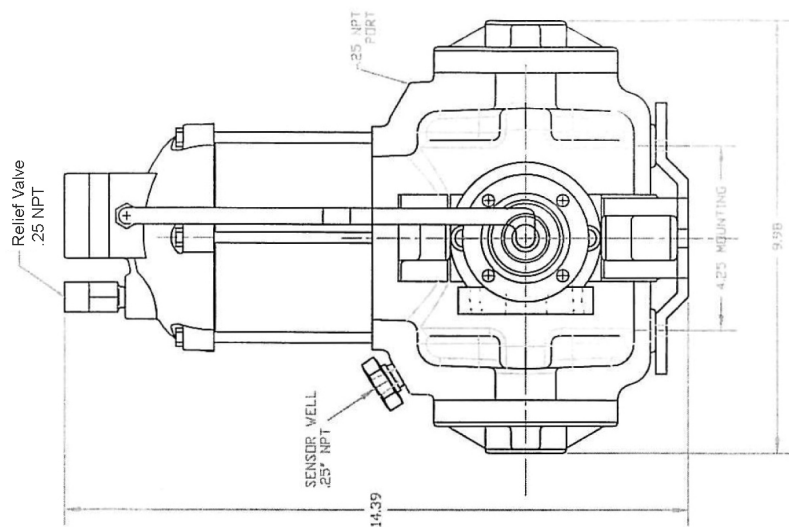
Inlet Check Valve (optional component)

- Disconnect the outlet piping from the meter assembly at the differential valve outlet flange.
- Remove the meter as detailed in the METER DISASSEMBLY section.
- Remove the back check valve assembly (#11a), which sits between the strainer and the adaptor on flow meter inlet.
- Manually open and close the valve to assure proper operations.
- Inspect for dirt or salt build-up and clean if necessary.
- Inspect the seals for wear or damage. Replace worn or brittle seals.
- Reassemble the valve and install in the strainer housing. This valve is optional and will not retrofit into strainer housing not originally supplied with the valve.
- Reassemble the system making sure bolts are torqued to the proper specifications

VP3075 Backcheck Valve Parts List

| | | QTY | Part No. |
|---|----------------------------------|-----|-----------|
| 1 | Piston, 3/4" backcheck valve | 1 | MP4001 |
| 2 | Spring | 1 | MS8031 |
| 3 | O-ring, UL BUNA | 1 | SL3114-UL |
| 4 | Valve body, 3/4" backcheck valve | 1 | MP3075-1 |
| 5 | Poppet, 3/4" backcheck valve | 1 | MP3076 |
| 6 | Screw, 10-32 x 0.375" SHCS | 1 | FS9651 |
| 7 | O-ring, UL | 1 | SL3218-UL |

Dimensional Drawing



Trouble Shooting

| <u>Problem</u> | <u>Probable Cause and Solution</u> |
|--|---|
| Leakage from seal cover. | <ul style="list-style-type: none">• Seal has been damaged due to shock• Cover bolts have not been tightened sufficiently• Replace seal and /or re-torque bolts |
| Product flows through meter but the register does not operate | <ul style="list-style-type: none">• Pulser is not functioning properly• Meter gears are jammed and not turning• Replace the pulser, inspect internal meter parts |
| Breaking teeth on gears. | <ul style="list-style-type: none">• Starting or stopping flow too rapidly.• Normal wear after long service• Replace gears• Correct system operation• Check pump by-pass setting. |
| No flow or low flow through the meter | <ul style="list-style-type: none">• Faulty non-functioning pump• Differential valve not open or not functioning. Replace valve• Meter “frozen” due to build up of salts or frozen material. Clean meter internals and inspect for damage• Vapor vent line valve shut or obstruction in vapor vent line. Open valve or remove obstruction• Strainer dirty and plugged. Clean Strainer• U-Cups on differential valve leaking. Replace U-Cups |
| Meter operates too slowly: | <ul style="list-style-type: none">• Differential valve internal mechanism faulty. Valve does not open fully.• Meter gears or rotors partially “salted”, enough to slow the rotating gears. To correct, clean gears.• Strainer partially plugged. Clean strainer basket.• Pump not functioning properly. Repair pump |
| Product flows through the meter but register does not record properly: | <ul style="list-style-type: none">• Pulse output board faulty, or not calibrated for electronic register.• Vapor release valve sticking.• Differential valve leaking.• Repair or replace as necessary. |

Flow Meter Calibration

SCL (Scaler/Calibrator/Linearizer)

Description: Tuthill SCL is a small electronic device designed to provide the function of a pulse **Scaler**, an electronic **Calibrator** and **Linearizer**. This electronics package replaces a mechanical gear plate and mechanical calibrator while at the same time providing the ability to improve the accuracy of a metering device during low flow operation, thus improving the overall meter accuracy, and extending the flow range of the metering device. The SCL may be used in conjunction with other Tuthill electronics to solve many of your electronic interface requirements.

Specifications:

- Input Voltage : 5Vdc and 6 to 12 Vdc
- Input Current : 25ma @ 5Vdc
- Operating Temperature : -40 °C to +85°C
(U/L T4 upper limit is +40C)
- Input signal : Hall Effect sensors, single or dual, or single ended input from 5Vdc logic
- Input Frequency : 2000 Hz (max)

Output:

- Quadrature Pulse
- Output Voltage : Proportional to power supply voltage
- Duty Cycle : Symmetrical Quadrature with 50/50 D.C.
- Output Frequency : (Input Frequency) X (ECF)
Scaled to application
- Linearizer : 32 points maximum
- Calibrator Range : +/- 3.0%
- Output pulse on-time : Fixed by firmware

OPERATION:

The SCL may be used to perform a number of functions depending upon the users application. The following is a brief description of several of the SCL functions.

SCALER MODE:

When operating in the Scaler mode only, the SCL applies a single error correction factor (ECF) to the incoming pulse signal. If a single correction factor is applied to the entire range of meter frequency inputs then the output frequency is proportional to the input frequency times the ECF (SCL Pulses out = SCL Pulses in times ECF). If the ECF is 1.0 (no scaling factor) the output frequency is equal to the input frequency.

As an example, use this feature when the customer's electronics requires a precise frequency or pulse resolution input. If the customer's electronics required 100 pulses per liter, then 100 PPL becomes the **base pulse resolution** based on which all input pulses are scaled. If, as an example, the meter is providing 108 pulses per liter, then an ECF of 0.925 (100/108) would be programmed into the SCL, and the output pulse frequency would be equivalent to the selected base resolution of 100 PPL.

LINEARIZER MODE:

If a metering device is not producing an output within the limits of accuracy required for an application, the SCL may be used as a linearizer. A linearizer is a device, which recognizes the output frequency of the metering device, and applies a correction factor (ECF), chosen for that frequency to improve the accuracy of the metering device.

The number of ECF points chosen for a specific application depends upon the accuracy of the metering device. In weights and measure applications, there is an ECF applied at each flow rate point where the meter accuracy varies by 0.25% from the previous flow rate point.

The ECF data is stored electronically in the SCL at the factory. The electronic chip storing this data is permanently attached to the printed circuit board. The ECF chip is marked with a code, that is used to reference the exact set of ECF data, that is supplied in your SCL device.

CALIBRATOR MODE:

The SCL is equipped with two rotary switches S3 and S4, and a two position switch S2. The three switches allow the SCL to adjust the pulse output up or down by 3%.

This allows the operator, or W&M authorities to calibrate the meter without having to alter scale factors in customer electronics. This feature is designed to replace mechanical calibrators used in the field for years to adjust the meter output to accurately match the volume in a proving vessel.

The calibrator feature may be used if the SCL is being used as a scaler only, or as a scaler/linearizer.

SWITCHES:

S1 : Allows the choice of either a single channel input, or a two channel quadrature input.

S2 : Is used in conjunction with S3 and S4.

If in the minus (-) position, an increase in the S3 and S4 switch settings will decrease the pulse output. A decrease in pulse output will increase the volume in a prover vessel. If in the plus (+) position, an increase in the S3 and S4 will increase the pulse output. An increase in pulse output will decrease the volume in the prover vessel.

S3/S4 Adjust the SCL pulse output up or down +/-3.0%. S3 and S4 will allow for 00-99 settings. Each increment changed in this setting, changes the SCL pulse output by approximately 0.03%

Flow Meter Calibration

METER CALIBRATION:

- * Flow meter re-calibration should be on a volume equal to 1 minute of flow at maximum flow rate.
- * All tests should be performed 3 times under identical conditions to confirm repeatability.
- * Maintain a permanent file for each flow meter, and record % change each time the meter is re-calibrated.

When the change is significantly higher than that found in previous re-calibrations, it is time to re-build the flow meter (replace the two oval gears).

METER CALIBRATION: The calibrator allows you to adjust the output of the SCL up or down, like a mechanical calibrator, +/- 3% in increments of 0.03%.

- After calibrating a known volume (X) into an accurate prover (or through a master meter with adequate resolution), compare with register reading (Y) and calculate correction:

$$\frac{X - Y}{X} \times 100 = \% \text{ correction}$$

To reduce the volume in a prover vessel, place switch S2 in the plus(+) position.

- Adjust the S3 and S4 to the position required for the necessary volume reduction in the prover can. Switch S3 and S4 represent readings of 00 to 99, and each increment will adjust the output approximately 0.03%.

Example:

Using a 50 gallon (189.27 liter) prover (can), the can reads 17.3 cubic inches (284 ml) high. The meter error is $(284/189,270) = 0.0015$ or 0.15%. To adjust the meter output, place S2 in the positive position, and set S3 and S4 to read 05. This is approximately a 0.15% adjustment.

Activate the Reset push button switch to enter the new program settings. Retest the flow meter.

- To increase the volume in the prover vessel. Place switch S2 in the negative (-) position, and set switches S3 and S4 to the proper settings to adjust the output. Activate the Reset push button switch to enter the new data.

NOTE: If S2 is in the plus (+) position, and S3 and S4 are at 15 as an example, then moving the position of S3 and S4 to 00 will provide a $(0.03 \times 15) = .45\%$ increase in the prover volume. To obtain a greater increase in the prover volume, S2 must be placed in the minus (-) position and S3 and S4 rotated to the proper position to obtain the desired change in pulse resolution. The opposite is true if S2 is already in the minus (-) position at the beginning of calibration.

- Finally:

- Re-seal the flow meter.
- Enter date and % correction on the permanent flow meter record.

As long as degree of change is moderate, the flow meter is in good condition.

If there is a sudden significant jump in correction required, the rotors are likely about worn out. Rotor replacement should be considered now, rather than letting further wear cause rotors to start rubbing on flow meter housing.

METER CALBRATION: INCREASED PRECISION.

The standard method for calculating the single point adjustment is to obtain the error as a percentage of the desired test volume. In the previous examples, an excess volume in the prover vessel of 284 ml became 0.15% and the adjustment was 05 on S3 and S4.

However, the 0.15% correctly needs to be applied to the nominal ECF for the particular meter profile in order to more precisely calculate the adjustment for S3 and S4. The nominal ECF is the particular profile base divided by the natural meter pulse resolution.

As an example, a meter type which is scaled to 100 ppl and has 410 ppg pulse resolution, has a nominal ECF of $378.5/410 = 0.9232$. 0.15% of 9232 is 13.84. When divided by 3, the switch setting is 04.6. In this example, 4.6 is rounded up to 05. This is the same result as before because the ECF is close to unity (1.0000). If the ECF was 0.4200, then the switch setting would be 02.

There are applications where the nominal ECF is not near unity. In those cases, the nominal ECF needs to be known and used for the calculation. If the standard calculation is used, the adjustment would be excessive and the meter technician would have to estimate the reduction in his settings and perform an additional test run.

Flow Meter Maintenance & Calibration Record

[illegible]



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